

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No. : 09/885,319 Confirmation No.: 4594
Applicant : Mark A. Stan, *et al.*
Filed : June 19, 2001
TC/A.U. : 1753
Examiner : Diamond, Alan D.

Docket No. : 1003 (previously 1613370-0006)
Customer No. : 007470

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

DECLARATION UNDER 37 C.F.R. § 1.131

I, the undersigned, declare that:

1. My name and residence is as listed below.
2. I am a joint inventor in the above-identified patent application ("The Patent Application").
3. The undersigned Hong Q. Hou participated in the development of processes for the fabrication of solar cells, and prepared records describing such processes, prior to March 29, 1999.
4. The document attached hereto as Exhibit 1 is a summary of an actual process control instruction sheet as stored in computer archival storage maintained by the assignee of the Patent Application, Emcore Corporation of Somerset, New Jersey ("Emcore"), at its

FALCALTO 60409 (2K)

Albuquerque, New Mexico facility. The print-out was printed from the archival storage file on May 4, 2004, as indicated by the date on the top right hand portion of page 1.

5. Associated file records of Emcore, attached hereto as Exhibit 2, with the actual dates being redacted, show that the date of the original document represented in Exhibit 1, and correspondingly the actual E6523 process run itself, was made prior to March 29, 1999.
6. Exhibit 1 is a summary of the growth "recipe" of a test run of a triple-junction solar cell. The "recipe" is a sequence of instructions for controlling an Emcore E400 Reactor (hereinafter, the "Reactor") installed at Emcore's facilities in Somerset, New Jersey, used for metal organic chemical vapor deposition (MOVCD) growth of identified chemical elements or compounds on the surface of a substrate contained in the reactor chamber.
7. Each line in the summary file represents a distinct layer of the solar cell or a process step performed as part of the fabrication process.
8. The detailed recipe control from which this summary was generated was loaded into a control computer of an E-400 model MOVCD reactor to control the "on" or "off" switches and amount of gas flow of each chemical from a bubbler through gas lines in the reactor.
9. The identified E6523 process identified in Exhibit 1 is one of a number of actual process runs conducted on a germanium substrate for research and development purposes relating to the deposition of surface layers for the creation of different solar cell semiconductor structures that were conducted on the Reactor in Somerset, NJ during 1999.

10. The undersigned Hong Q. Hou participated in both the conception and specification of the materials systems and layers of the desired solar cell, and the actual implementation and performance of the E6523 process of Exhibit 1 on the Reactor. The E6523 process of Exhibit 1 resulted in the fabrication of a wafer including a solar cell having at least an InGaP layer formed directly on the surface of a germanium substrate, *i.e.*, a layer containing both In and P.
11. Referring to page 1 of Exhibit 1, the entry beginning with "TMAI" represents the process instructions for a first reactant, which in the E6523 process actually corresponds to the flow of trimethylindium. The use of the term "Al" in the "TMAI" was included in the software control instruction because the software identifying the register of the control line was designed and used in the past for a similar process involving aluminum, rather than indium. Since the use of indium as a constituent element was a new idea, the actual chemical compound in the bubbler connected to the "Al" line was changed to trimethylindium. However, the computer software had not yet been rewritten to designate "indium" or "In" instead of "aluminum" or "Al," along with its deposition conditions when the actual E6523 process was performed.
12. The process associated with the flow of trimethylindium at various timed intervals is represented by the sequence of columns to the right of the process instruction entries labeled Layer #1, Layer #2, etc., with various specified time durations.
13. The process instructions on page 1, line 4 beginning with "TMGa# 1-4," and continuing on to the first two entries on page 2, correspond to the flow of trimethylgallium, the metal organics for gallium.

14. On page 2, line 3 of Exhibit 1, the process instructions labeled "ASH3#2_42" on page 2, line 3, corresponds to the flow of arsine.
15. On page 2, line 4, the entry line labeled "PH3_43" identifies a process instruction to the Reactor associated with the flow of phosphine at various timed intervals represented by the columns (labeled on page 1) as Layer #1 (4.000 min), Layer #2 (6.000 min), etc. The letters "V" and "R" indicate that the flow is switched from a "vent" position to a "run" position, with the phosphine being introduced into the reactive chamber at the time intervals corresponding to the "R" notations.
16. The nucleation layer is designed to be n-type doped in InGaP on Ge. During the growth of the nucleation layer of InGaP, only TMIn and TMG were supplied for group-III growth; phosphine for group-V growth, and a doping quantity of silane was provided as dopant.
17. The ratio of gas flows between TMIn and TMGa were adjusted to make the lattice constant of InGaP match that of the Ge substrate.
18. Although it is not designated in Exhibit 1, a germanium substrate was selected and used in the E6523 process.
19. The undersigned Mark A. Stan, Nein Y. Li, Frank A. Spadafora, Paul R. Sharps, and Navid S. Fatemi each participated in the development of the subject matter claimed in this patent application after March 29, 1999.

20. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statement were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. § 1001.

Name: Mark A. Stan

City: Albuquerque, NMSignature: Mark A. Stan Date: 3-29-2006

Name: Nein Y. Li

City: Albuquerque, NMSignature: Nein Y. Li Date: 3-29-06

Name: Frank A. Spadafora

City: BADEN, PASignature: Frank A. Spadafora Date: 3-22-2006

Name: Hong Q. Hou

City: _____

Signature: _____ Date: _____

Name: Paul R. Sharps

City: Albuquerque, NMSignature: Paul R. Sharps Date: 3/29/06

Name: Navid S. Fatemi

City: Albuquerque, NMSignature: Navid S. Fatemi Date: 3/29/06

Name: Mark A. Stan

City: Albuquerque, NMSignature: Mark A. StanDate: 3/24/06

Name: Nein Y. Li

City: _____

Signature: _____

Date: _____

Name: Frank A. Spadafora

City: _____

Signature: _____

Date: _____

Name: Hong Q. Hou

City: Arcadia, CASignature: Hong Q. HouDate: 04/10/06

Name: Paul R. Sharps

City: _____

Signature: _____

Date: _____

Name: Navid S. Fatemi

City: _____

Signature: _____

Date: _____

EXHIBIT 1

E6523 Process

5/4/2004
11:47 AM
Page 1

Emcore Process Printout

This process is stored in the file :
Directory : \\mat\sys\User\ech6\runs
Filename : E6523TJN.ERF

Total Run Time : 94.501 min

This printout contains the following fields :
Process Control Line Set Point
Process Control Line Command

Process comments :

NUC66 recipe: P drive-in instead of As drive-in
2P, 3P mixed platter with new pockets
BASELINE: e6517 WITH MODIFICATIONS AND SPECIFICS
Modifications: Baseline for TJN runs
Layer30, Time 1.9>0.95 min (InGaAlP BSF), InGaP base 10>6.5 min
Purpose: P drive-in with InGaP nucleation
Test: Surfscan, Polaron, PL, and V-probe

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Page 2

Emcore Process Printout

	Layer # 1	Layer # 2	Layer # 3	Layer # 4	Layer # 5
	4.000min	6.000min	6.000min	2.000min	2.000min
TMA1_7	400.00ccm I	400.00ccm I	400.00ccm V	650.00ccm V	852.00ccm V
TMA1#1 Pres_23	250.0Tor R	250.0Tor R	250.0Tor R	250.0Tor R	250.0Tor R
TMA1#1_7 MoleFr	0.5700per I	0.5700per I	0.5700per I	0.5700per I	0.5700per I
TMGa#1_4	41.00ccm I	41.00ccm I	41.00ccm I	41.00ccm I	41.00ccm V
TMGa#1 Pres_20	950.0Tor R	950.0Tor R	950.0Tor R	950.0Tor R	950.0Tor R
TMGa#2_5	140.00ccm I	140.00ccm I	140.00ccm I	140.00ccm I	140.00ccm I
TMGa#2 Pres_21	350.0Tor	350.0Tor	350.0Tor	350.0Tor	350.0Tor

Page 1

E6523 Process					
	R	R	R	R	R
TEGa_6	36.10ccm I	36.10ccm I	36.10ccm I	36.10ccm I	36.10ccm I
TEGa Pres_22	475.0Tor R	475.0Tor R	475.0Tor R	475.0Tor R	475.0Tor R
ASH3#2_42	0.0ccm V	0.0ccm V	0.0ccm V	0.0ccm V	0.0ccm V
PH3_43	0ccm V	400ccm R	400ccm R	400ccm R	1800ccm R
CC14_1	200.00ccm I	200.00ccm I	200.00ccm I	200.00ccm I	200.00ccm I
CC14 Dil_57	200.0ccm R	200.0ccm R	200.0ccm R	200.0ccm R	200.0ccm R
CC14 mix_58	133.00ccm R	133.00ccm R	133.00ccm R	133.00ccm R	133.00ccm R
CC14 Pres_17	300.0Tor R	300.0Tor R	300.0Tor R	300.0Tor R	300.0Tor R

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Emcore Process Printout					
	Layer # 6	Layer # 7	Layer # 8	Layer # 9	Layer # 10
	0.200min	0.650min	3.000min	0.200min	12.000min
TMA1_7	852.00ccm V	852.00ccm R	400.00ccm I	400.00ccm I	400.00ccm I
TMA1#1 Pres_23	250.0Tor R	250.0Tor R	250.0Tor R	250.0Tor R	250.0Tor R
TMA1#1_7 Mo1eFr	0.5700per R	0.5700per R	0.6000per I	0.6000per I	0.6000per I
TMGa#1_4	41.00ccm V	41.00ccm R	100.00ccm V	100.00ccm V	100.00ccm R
TMGa#1 Pres_20	950.0Tor R	950.0Tor R	950.0Tor R	950.0Tor R	950.0Tor R
TMGa#2_5	140.00ccm I	140.00ccm I	140.00ccm V	140.00ccm V	140.00ccm R
TMGa#2 Pres_21	350.0Tor R	350.0Tor R	350.0Tor R	350.0Tor R	350.0Tor R
TEGa_6	36.10ccm I	36.10ccm I	36.10ccm I	36.10ccm I	36.10ccm I

Page 2

E6523 Process					
TEGa Pres_22	475.0Tor R	475.0Tor R	475.0Tor R	475.0Tor R	475.0Tor R
ASH3#2_42	0.0ccm V	0.0ccm V	0.0ccm V	1200.0ccm V	1200.0ccm R
PH3_43	2000ccm R	2000ccm R	400ccm R	400ccm R	0ccm V
CC14_1	200.00ccm I	200.00ccm I	200.00ccm I	200.00ccm I	200.00ccm I
CC14 Dil_57	200.0ccm R	200.0ccm R	200.0ccm R	200.0ccm R	200.0ccm R
CC14 mix_58	133.00ccm R	133.00ccm R	133.00ccm R	133.00ccm R	133.00ccm R
CC14 Pres_17	300.0Tor R	300.0Tor R	300.0Tor R	300.0Tor R	300.0Tor R

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Emcore Process Printout					
	Layer # 11 2.400min	Layer # 12 0.100min	Layer # 13 1.330min	Layer # 14 0.500min	Layer # 15 1.000min
TMA1_7	400.00ccm I	400.00ccm I	400.00ccm I	400.00ccm I	400.00ccm I
TMA1#1 Pres_23	250.0Tor R	250.0Tor R	250.0Tor R	250.0Tor R	250.0Tor R
TMA1#1_7 Mo1eFr	0.6000per I	0.6000per I	0.6000per I	0.6000per I	0.6000per I
TMGa#1_4	100.00ccm R	54.17ccm V	54.17ccm R	54.17ccm V	54.17ccm R
TMGa#1 Pres_20	950.0Tor R	950.0Tor R	950.0Tor R	950.0Tor R	950.0Tor R
TMGa#2_5	140.00ccm R	140.00ccm I	140.00ccm I	140.00ccm I	140.00ccm V
TMGa#2 Pres_21	350.0Tor R	350.0Tor R	350.0Tor R	350.0Tor R	350.0Tor R
TEGa_6	36.10ccm I	36.10ccm V	36.10ccm V	36.10ccm V	36.10ccm R
TEGa Pres_22	475.0Tor R	475.0Tor R	475.0Tor R	475.0Tor R	475.0Tor R
ASH3#2_42	1200.0ccm R	400.0ccm R	400.0ccm R	400.0ccm R	400.0ccm R

Page 3

E6523 Process

PH3_43	0ccm V	0ccm V	0ccm V	0ccm V	0ccm V
CC14_1	200.00ccm V	200.00ccm V	200.00ccm V	200.00ccm V	200.00ccm R
CC14 Dil_57	200.0ccm R	200.0ccm R	200.0ccm R	200.0ccm R	200.0ccm R
CC14 mix_58	133.00ccm R	133.00ccm R	133.00ccm R	133.00ccm R	133.00ccm R
CC14 Pres_17	300.0Tor R	300.0Tor R	300.0Tor R	300.0Tor R	300.0Tor R

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Emcore Process Printout

	Layer # 16 1.000min	Layer # 17 0.100min	Layer # 18 9.000min	Layer # 19 3.000min	Layer # 20 2.000min
TMA1_7	400.00ccm I	400.00ccm I	400.00ccm I	400.00ccm V	650.00ccm V
TMA1#1 Pres_23	250.0Tor R	250.0Tor R	250.0Tor R	250.0Tor R	250.0Tor R
TMA1#1_7 MoleFr	0.6000per I	0.6000per I	0.6000per I	0.6000per I	0.6000per I
TMGa#1_4	54.17ccm R	100.00ccm V	100.00ccm R	100.00ccm R	100.00ccm R
TMGa#1 Pres_20	950.0Tor R	950.0Tor R	950.0Tor R	950.0Tor R	950.0Tor R
TMGa#2_5	140.00ccm V	140.00ccm V	140.00ccm R	140.00ccm R	140.00ccm R
TMGa#2 Pres_21	350.0Tor R	350.0Tor R	350.0Tor R	350.0Tor R	350.0Tor R
TEGa_6	36.10ccm R	36.10ccm I	36.10ccm I	36.10ccm I	103.00ccm I
TEGa Pres_22	475.0Tor R	475.0Tor R	475.0Tor R	475.0Tor R	475.0Tor R
ASH3#2_42	1000.0ccm R	1200.0ccm R	1200.0ccm R	1200.0ccm R	1200.0ccm R
PH3_43	0ccm V	0ccm V	0ccm V	0ccm V	0ccm V
CC14_1	50.00ccm	200.00ccm	200.00ccm	200.00ccm	200.00ccm

Page 4

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Joe Conklin/Emcore
05/05/2004 07:08 AM

To: Paul Sharps/Emcore@Emcore
cc: Rick Stall/Emcore@Emcore
bcc:
Subject: Re: Fw: GainP2 Nucleation

Exploring - Runs E6426-6600

File Edit View Go Favorites Tools Help

Back Forward Up Cut Copy Paste Undo Delete Properties View

Address D:\ECH6\Solar Cell Archives\Icarus\Runs E6426-6600

Folders	Name	Size	Type	Modified
Condensed Runs 2003	E6519tjn	18KB	ERF File	
Ech7	E6520tjn	18KB	ERF File	
ECR Recipes	E6521tjn	18KB	ERF File	
Elka Pins condensed runs 2001	E6522tjn	18KB	ERF File	
Emcore	E6523tjn	19KB	ERF File	
Golden	E6524tjn	18KB	ERF File	
Maintenance	E6525tjn	18KB	ERF File	
Motion	E6527std	13KB	ERF File	
Qs	E6528std	18KB	ERF File	
Recipes History	E6529std	18KB	ERF File	
Runs	E6530tjn	18KB	ERF File	
Solar Cell Archives	E6531tjn	19KB	ERF File	
Alerts	E6532tjn	19KB	ERF File	
Dev_arc	E6533tjn	19KB	ERF File	
Dev_CondensedRuns	E6534tjn	18KB	ERF File	
EPVCondensedRuns	E6535tjn	20KB	ERF File	
Icarus	E6536tjn	18KB	ERF File	
Runs E6100-E6150	E6537tjn	18KB	ERF File	
Runs E6150-E6200	E6538pt	18KB	ERF File	
Runs E6200-E6300	E6539pt	18KB	ERF File	
Runs E6300-E6375	E6540std	13KB	ERF File	
Runs E6376-E6425	E6541pt	18KB	ERF File	
Runs E6426-6600	E6542pt	18KB	ERF File	
Runs E6027-E6149	E6543brg	5KB	ERF File	
Icarus Condensed Runs	E6544ugs	5KB	ERF File	
Retired Recipes	E6545plo	8KB	ERF File	
Saved	E6546plo	8KB	ERF File	
Special Teams	E6547plo	8KB	ERF File	
Yield enhancement	E6548plo	8KB	ERF File	
Sys on 'Mfg' (E:)	E6549ngp	9KB	ERF File	
D_drive on 'Dedray' (F:)	E6550ngp	9KB	ERF File	
Aadatafolder on 'Emmpert' (G:)	E6551ngp	9KB	ERF File	
Interdepartmental on 'Njsoms01' (I:)	E6552ngp	9KB	ERF File	
Sys on 'Mat' (M:)	E6553ngp	7KB	ERF File	
users on 'njsoms01.emcore.us' (P:)				

217 object(s) 3.16MB (Disk free space: 0 bytes)

Start [Icons] [New Memo - Lotus Notes] [Exploring - Ech6] [Exploring - Runs E64...

Paul Sharps